Cuadernos de Psicología del Deporte, vol. 26, 3, 335-352
Recibido: 05/04/2026
Aceptado: 31/08/2026

Murcia (España) ISSN edición impresa:1578-8423
ISSNediciónweb(*http://revistas.um.es/cpd*):1989-5879

Ugalde-Ramírez, J. A., Sánchez-Ureña, B., Monge-Montero, M. A., Ibáñez-Godoy, S., Gutiérrez-Vargas, R. & Pino-Ortega, J. (2026). Relative Age Effect in Youth Athletes According to Sex, Sport Discipline, Age Category, and Sport Performance. Analysis of the National Sport Games of Costa Rica. *Cuadernos de Psicología del Deporte, 26*(3), 335-352

Efectos de la Edad Relativa en Atletas Jóvenes Según el Sexo, la Disciplina Deportiva, Categoría de Edad y el Rendimiento Deportivo. Análisis de los Juegos Deportivos Nacionales de Costa Rica

Relative Age Effect in Youth Athletes According to Sex, Sport Discipline, Age Category, and Sport Performance. Analysis of the National Sport Games of Costa Rica

Efeito da Idade Relativa em Jovens Atletas de Acordo com o Sexo, a Modalidade Esportiva, a Categoria de Idade e o Desempenho Esportivo: Análise dos Jogos Desportivos Nacionais da Costa Rica

Ugalde-Ramírez, Jose Alexis[1,3], Sánchez-Ureña, Braulio[1], Monge-Montero, Minor Andrés[2], Ibáñez-Godoy, Sergio[3], Gutiérrez-Vargas, Randall[1], Pino-Ortega, Jose[4]

[1]*Escuela de Ciencias del Movimiento Humano y Calidad de Vida, Universidad Nacional, Heredia, Costa Rica;* [2]*Departamento de Deporte y Recreación, Instituto Costarricense del Deporte y Recreación, San José, Costa Rica;* [3]*Facultad de Ciencias del Deporte, Universidad de Extremadura, Cáceres, España;* [4]*Facultad de Ciencias del Deporte, Universidad de Murcia, Murcia, España*

Resumen

El objetivo de este estudio fue explorar el Efecto de la Edad Relativa (RAE) en atletas jóvenes según el sexo, la disciplina deportiva, la categoría de edad y el rendimiento deportivo en los Juegos Deportivos Nacionales 2024 (JDN-2024) de Costa Rica. Se analizaron un total de 16357 atletas de 22 disciplinas que compitieron en la fase clasificatoria de los JDN-2024. De estos, 5030 avanzaron a la fase final. Se establecieron los cuartiles de nacimiento: Q1= 1 de enero - 31 de marzo, Q2= 1 de abril - 30 de junio, Q3= 1 de julio - 30 de septiembre y Q4= 1 de octubre - 31 de diciembre. Los resultados confirmaron la presencia del RAE en atletas masculinos y en deportes de equipo, tanto en la fase clasificatoria como en la fase final de los JDN-2024. Los nacidos en Q1 estuvieron significativamente sobrerrepresentados en comparación con los nacidos en Q4 (V= 0,02 - 0,04). Entre los atletas masculinos, se encontró RAE en fútbol en la fase clasificatoria (V= 0,06) y en taekwondo durante la fase final (V= 0,16). También se mostró un desequilibrio de cuartiles en el baloncesto masculino en la fase final, fuera del contraste Q1-Q4 (V= 0,15). En atletas femeninas, se observó una inversión del RAE únicamente en ajedrez en la fase clasificatoria (V= 0,10). El RAE apareció a los 16, 19 y ≥21 años en atletas masculinos, y a los 15 y 19 años en deportes de equipo (V= 0,04 - 0,09). Nacer en Q1 se asoció con una probabilidad ligeramente mayor de avanzar a la fase final en deportes individuales (V= 0,02); sin embargo, no se encontró una asociación estadísticamente significativa entre el cuartil de nacimiento y la obtención de medallas. Por lo tanto, aunque el RAE estuvo presente en el proceso de selección, no determinó el rendimiento deportivo.

Palabras clave: cuartil de nacimiento, identificación del talento, deporte juvenil, torneo, América Central.

Correspondencia: **Jose Alexis Ugalde-Ramírez.** Dirección Postal: Universidad Nacional, Heredia, Costa Rica, 86-3000. Tel: +506 89649777. Email: jose.ugalde.ramirez@una.cr

RAE in a national youth tournament, Costa Rica

ABSTRACT

This study aimed to explore the Relative Age Effect (RAE) among youth athletes according to sex, sport discipline, age category, and performance at the National Sport Games (Juegos Deportivos Nacionales 2024 [JDN-2024]) of Costa Rica. A total of 16357 athletes from 22 disciplines who competed in the qualifying phase of the JDN-2024 were analyzed. Of these, 5030 advanced to the final phase. Birth quartiles were established: Q1=January 1 - March 31, Q2=April 1 - June 30, Q3=July 1 - September 30, and Q4=October 1 - December 31. The findings confirmed the presence of RAE among male athletes and in team sports both in the qualifying and final phases for JDN-2024. Those born in Q1 were significantly overrepresented compared with those born in Q4 (V= 0.02 - 0.04). Among male athletes, RAE was found in football in the qualifying phase (V= 0.06) and taekwondo during the final phase (V= 0.16). A quartile imbalance was also shown in male basketball in final phase, outside the Q1-Q4 contrast (V= 0.15). In female athletes, RAE reversal was observed only in chess in the qualifying phase (V= 0.10). RAE appeared at 16, 19, and ≥21 years among male athletes, and at 15 and 19 years within team sports (V= 0.04 - 0.09). Being born in Q1 was associated with a slightly higher likelihood of advancing to the final phase in individual sports (V= 0.02); however, no statistically significant association was found between birth quartile and medal attainment. Therefore, while RAE was present in the selection process, it did not determine sport performance.

Keywords: birthdate quartile, talent identification, youth sport, tournament, Central America.

RESUMO

O objetivo deste estudo foi explorar o Efeito da Idade Relativa (RAE) em jovens atletas considerando o sexo, a modalidade esportiva e a categoria de idade e o desempenho esportivo nos Jogos Desportivos Nacionais (Juegos Deportivos Nacionales 2024 [JDN-2024]) da Costa Rica. Um total de 16357 atletas de 22 modalidades que competiram na fase classificatória dos JDN-2024 foi analisado. Destes, 5030 avançaram para a fase final. Os quartis de nascimento foram definidos como: Q1= 1 de janeiro - 31 de março, Q2= 1 de abril - 30 de junho, Q3= 1 de julho - 30 de setembro e Q4= 1 de outubro -31 de dezembro. Os resultados confirmaram a presença do RAE em atletas masculinos e em modalidades coletivas, tanto na fase classificatória quanto na fase final dos JDN-2024. Os nascidos no Q1 estiveram significativamente sobrerrepresentados em comparação com os nascidos no Q4 (V= 0,02 - 0,04). Entre os atletas masculinos, o RAE foi identificado no futebol na fase classificatória (V= 0,06) e no taekwondo durante a fase final (V= 0,16). Também se observou um desequilíbrio de quartis no basquetebol masculino na fase final, fora do contraste Q1-Q4 (V= 0,15). Nas atletas do sexo feminino, observou-se uma inversão do RAE apenas no xadrez na fase classificatória (V= 0,10). O RAE apareceu aos 16, 19 e ≥21 anos em atletas masculinos, e aos 15 e 19 anos em modalidades coletivas (V= 0,04 - 0,09). Nascer no Q1 esteve associado a uma probabilidade ligeiramente maior de avançar para a fase final nas modalidades individuais (V= 0,02); no entanto, não foi encontrada uma associação estatisticamente significativa entre o quartil de nascimento e a conquista de medalhas. Portanto, embora o RAE estivesse presente no processo de seleção, não determinou o desempenho esportivo.

Palavras-chave: quartil de nascimento, identificação de talentos, esporte juvenil, torneio, América Central.

INTRODUCTION

In youth sport, athletes are often grouped by chronological age to promote equal participation opportunities. Most sports organizations and development programs use a one-year calendar cut-off period to classify the athletes into age categories, usually from January 1st to December 31st (Cobley et al., 2009; Faber et al., 2020). Although this approach is intended to promote equitable participation, it may unintentionally create age-related disparities within the same competitive category, with athletes born earlier in the selection year outperforming their relatively younger peers (Jakobsson et al., 2021; Wattie et al., 2015).

This phenomenon, known as the relative age effect (RAE), refers to the overrepresentation of athletes born in the early months of the selection year and the underrepresentation of those born later (Sweeney et al., 2024; Tascioglu et al., 2023). Commonly, RAE is attributed to differences in biological maturation, physical attributes, and psychosocial factors that may confer temporary advantages to relatively older athletes during childhood and adolescence (Bezuglov et al., 2022; Kearney et al., 2018; Musch & Grondin, 2001; Silva et al., 2022), which can be transferred and reflected in senior teams' rosters (Ferragut et al., 2021; Lupo et al., 2019; Roberts et al., 2021). Since these advantages can influence coaches' perceptions of athletes' talent when selecting them, premature discrimination may occur, excluding relatively younger athletes from participating in higher-level training processes and high-level competition tournaments, negatively impacting their sports careers (Gil et al., 2021; Hollings et al., 2014; Lidor et al., 2021).

RAE has been widely studied across sports and competitive levels. Research has been conducted across a variety of sports in nations such as Switzerland (Romann et al., 2018), Brazil (de Almeida-Neto et al., 2023), Sweden (Jakobsson et al., 2021), Norway (Kirkeberg et al., 2022), Italy (Brustio et al., 2023), England (Reed et al., 2017) and Israel (Lidor et al., 2021), consistently demonstrating the presence of RAE and recognizing it as a bias that must be addressed to ensure fairness in talent selection processes.

Previous research has shown that the magnitude of the RAE may vary according to factors such as age, sex, sport discipline, and competition performance level. RAE affects both team and individual sports. In this sense, football stands out as a discipline that has been well-documented across multiple age categories for many years (Roberts et al., 2021), although it also manifests in basketball (Ibáñez et al., 2018), volleyball (Rubajczyk & Rokita, 2020), and handball (de la Rubia et al., 2021). In individual sports, the presence of RAE has been documented among athletes in both track and field events (Difernand et al., 2023; Saavedra-García et al., 2016), in swimming (Lorenzo-Calvo et al., 2021), tennis (Aku & Yang, 2024), and combat sports (de Almeida-Neto et al., 2023). Furthermore, the RAE impact tends to be more pronounced in male than female athletes (Lidor et al., 2021; Romann et al., 2018; Smith et al., 2018). Likewise, lower participation density in a sport, as well as different selection criteria, may increase or decrease the RAE impact in the sport (Kelly et al., 2022; Porto et al., 2021; Voet et al., 2022).

On the other hand, the evidence points to a possible relationship between the RAE and competitive results (de la Rubia et al., 2020). Some studies report an association between relative age and short-term competitive success, such as ranking positions, playing time, or medal attainment. For example, in U15 and U20 basketball categories, RAE has been linked to team success, greater playing time for relatively older players, and performance metrics (Arrieta et al., 2016; Tascioglu et al., 2023). In women’s handball, performance statistics are better for players born in the earlier quartiles compared to those born later in the year (de la Rubia et al., 2021). In track and field events, athletes born in the first quartile of the year won more medals than those born in other quartiles (Bezuglov et al., 2022). Additionally, RAE raises the likelihood of winning in combat sports such as taekwondo (Minsoo et al., 2022). However, there are also studies that have found no relationship between the RAE and technical-tactical collective and individual performance in team sport (de Oliveira Castro et al., 2024; Folle et al., 2026).

Based on the above, the available evidence indicates that RAE is a complex phenomenon that manifests mainly in selection and progression processes within youth sport systems. Yet this evidence comes mostly from Europe, Asia, and South America, and usually from a single sport or a single sex, which leaves open how RAE behaves across a whole national youth system examined at once. Central America, in particular, has barely been studied, so little is known about how the effect operates in systems with different organizational structures, participation patterns, and talent-development pathways. In Costa Rica, the National Sport Games (Juegos Deportivos Nacionales, [JDN]) is a government-run annual program that promotes sport participation among young athletes nationwide across several disciplines and works as a strategic platform for identifying talent with the potential to enter high-performance pathways and reach national teams. Analyzing the National Sport Games 2024 (JDN-2024) makes it possible to examine all registered athletes, 22 disciplines, both sexes, and two competitive phases within a single dataset. Therefore, this study aimed to explore the presence of RAE among young athletes participating in the JDN-2024, according to sex, sport, age category, and sport performance.

Sociedad Iberoamericana de Psicología del Deporte

MATERIAL AND METHOD

Study design

This study followed a non-experimental, retrospective and ex post facto design with a descriptive-comparative and associational approach (Ato et al., 2013). This design allowed for the comparison of birth quartile distributions across different groups (sex, sport type, age, and competitive phase) and to examine the associations between relative age (birth quartile) and competitive outcomes (qualification and medal attainment).

Participants

This study used a census, non-probabilistic sampling approach, encompassing the full population of athletes formally registered and eligible to compete in the JDN-2024. A total of 16357 athletes from 22 sports disciplines competed in the qualifying phase across different regions of Costa Rica, of whom 5030 advanced to the final phase. Among all qualifying-phase participants, 10229 were male (16.91 ±2.64 years; 2653 qualified for the final phase) and 6128 were female (16.01 ±2.91 years; 2377 qualified). A total of 7731 athletes competed in seven team sports, namely basketball, football, futsal, volleyball, beach volleyball, handball, and baseball (male only), with an average age of 17.63 ±1.97 years, of whom 1426 advanced to the final phase. The remaining 8626 athletes participated in 15 individual sports, namely athletics, boxing, chess, cycling, artistic gymnastics, rhythmic gymnastics (female only), weightlifting, judo, karate, swimming, skating, taekwondo, tennis, table tennis, and triathlon, with an average age of 15.64 ±3.04 years, of whom 3604 advanced to the final phase. Each sport had its own age range for participation, competitive format, and qualification criteria, in accordance with national and international guidelines. The only inclusion criterion was formal registration in the ICODER database to compete in the qualifying phase; no exclusion criteria applied, as the entire population was analyzed and the records supplied were complete for the variables of interest. Table 1 presents the distribution of athletes by birth quartile, their average age by sex, and sport discipline.

Instruments and variables

The primary instrument was the official digital database managed by the Instituto Costarricense del Deporte y la Recreación (ICODER), which holds the registration and competition records for every athlete taking part in the JDN-2024. The data for each athlete included: chronological age (years), date of birth, sex (male/female), sport discipline, and medal attainment (for most sports).

The variables were operationalized as follows: Sex was coded as a dichotomous variable (male/female). The sport was recorded as the specific sport discipline (n= 22) in which each athlete competed and was grouped into two types: individual and team sports. The age category was defined according to the competitive age groups established for each discipline, in accordance with the guidelines of national and international federations, so that athletes were assigned to the category in which they were officially registered to compete. Competitive performance was recorded using two variables: qualification, coded as whether the athlete advanced from the qualifying round to the final round (yes/no), and medal win, coded as whether the athlete won a medal in the final round (yes/no). Medal data were available for 4558 of the 5030 finalists, as three disciplines did not report them.

Considering that the cut-off date for sports in Costa Rica is January 1, the RAE variable was created and categorized into the following quartiles: Q1= January 1-March 31, Q2= April 1-June 30, Q3= July 1-September 30, and Q4= October 1-December 31. This quartile classification was the primary independent variable in all analyses.

Table 1
Distribution of athletes according to sport discipline and sex.

	Female				Male				Age mean
Sport	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	
Athletics	186	177	184	201	216	195	184	213	16.36 ±3.04
Boxing	52	76	67	55	197	229	200	205	16.86 ±2.24
Chess	31	54	44	58	150	142	141	134	13.25 ±3.17
Cycling	21	20	23	21	99	113	94	112	16.94 ±1.93
Artistic gymnastics	79	72	72	85	8	14	12	8	12.32 ±2.72
Rhythmic gymnastics	39	55	41	40	-	-	-	-	12.48 ±2.80
Weightlifting	28	17	28	29	31	32	17	31	18.83 ±2.84
Judo	36	32	45	31	51	57	58	59	16.70 ±2.35
Karate	71	81	71	79	90	82	89	94	15.83 ±2.57
Swimming	97	92	105	86	68	83	98	80	15.36 ±2.38
Skating	21	25	28	29	11	18	13	13	13.76 ±2.44
Taekwondo	126	120	138	115	176	146	176	160	15.89 ±2.57
Tennis	43	31	34	29	49	53	62	66	14.46 ±2.20
Table tennis	38	27	31	39	64	42	70	60	14.19 ±3.09
Triathlon	23	23	16	21	33	32	32	26	17.69 ±3.40
Basketball	64	49	67	56	129	140	148	124	18.58 ±1.60
Handball	40	33	33	38	52	35	49	44	19.58 ±1.73
Baseball	-	-	-	-	74	56	68	56	15.98 ±2.34
Football	243	236	219	249	691	656	624	500	16.75 ±1.30
Futsal	103	118	120	98	229	209	234	199	18.68 ±2.03
Volleyball	152	178	159	165	219	189	226	215	18.06 ±2.16
Beach volleyball	14	16	23	17	23	16	23	13	18.10 ±2.13
Overall	1507	1532	1548	1541	2660	2539	2618	2412	16.58 ±2.78

Procedure

First, contact was established with the administrative staff of ICODER to discuss the scope of the research and the procedures for collecting official data. The database was supplied by ICODER after the JDN-2024 and contained sport-related variables for participants, including chronological age (years), date of birth (day/month/year), sex (male/female), sport discipline, and whether the athlete won a medal. However, for rhythmic gymnastics, tennis, and table tennis, it was not possible to access information on medal attainment.

The information was reviewed and cleaned up in Microsoft Excel. The study followed the Declaration of Helsinki (World Medical Association, 2013) and the ethical standards for sport and exercise science research (Harriss et al., 2019). This study is a complementary analysis carried out under a broader doctoral project on relative age in Costa Rican youth and professional sport, which was approved by the Bioethics and Biosafety Committee of the University of Extremadura (approval no. 144/2024). Individual informed consent was not obtained. The data were provided as a secondary administrative record once the event was over, and with >16000 athletes already registered and competing, retrospective consent was not feasible. Because the dataset was fully anonymized and involved no contact with participants, no assent or parental consent was sought for the minors included. ICODER authorized their use for research purposes. All records were handled confidentially and processed in line with Organic Law 3/2018 on the protection of personal data and digital rights and with the EU General Data Protection Regulation.

Statistical Analysis

Given the categorical nature of the data, chi-square tests were used throughout. These tests were performed in IBM SPSS Statistics (v26.0), with statistical significance set at $p< 0.050$. It was verified that there were more than five expected frequencies in more than 80% of the cells across all analyses. Chi-square goodness-of-fit tests were applied to analyze the distribution of birth quartiles, with the expected distribution set at 25% per quartile, assuming uniform birth rates across the calendar year, consistent with standard practice in RAE research (Cobley et al., 2009; Smith et al., 2018). These analyses were conducted independently for men and women, for individual and team sports, and for both the qualifying and final phases of JDN-2024. Specific chi-square tests were performed separately for each sport within each sex, and for each age category (independently for men and women, and for individual and team sports). In addition, chi-square tests of independence on 4 × 2 cross-tabulations were then used to assess the associations of birth quartile (Q1 - Q4) with qualification for the final phase and with medal attainment, run separately for the male, female, individual, and team samples. Odds Ratios (OR) and their respective 95% Confidence Intervals (95% CI) were calculated to compare Q1 vs Q4 (Lidor et al., 2021; Romann et al., 2018). Because, the standard coefficient tends to overestimate association in finite samples, especially in tables with more categories and smaller subsamples, effect size was evaluated using bias-corrected Cramer's V (Bergsma, 2013) computed in R (v4.6). The correction was applied to both the goodness-of-fit and the independence analysis. Values were interpreted with Cohen's (1988) thresholds according to the degrees of freedom of each table. For the quartile distribution analyses (df= 3), 0.06, 0.17, and 0.29 denoted small, medium, and large effects; for the 4 × 2 independence analyses (df= 1), the corresponding values were 0.10, 0.30, and 0.50.

RESULTS

RAE by Sex and Sport Type

When all athletes of the qualifying phase were considered (without stratification by sex or sport type), chi-square goodness-of-fit analyses did not find a statistically significant result; however, OR and 95% CI analyses suggested a Q1 vs. Q4 disparity. In the final-phase sample, RAE was evident, with more athletes born in Q1 than in Q4. Upon stratification by sex and sport type, RAE was evident among male athletes and in team sports during both phases, with players born in Q1 being overrepresented and small-to-medium effect sizes. No significant quartile effects were observed among female athletes or in individual sports (Table 2).

Table 2
Statistical analysis summary of the distributions of athletes in the qualification phase and final phase of JDN-2024 by sport type and sex.

	Qualifying phase				*Final phase*			
	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**
Whole sample	7.54	0.057	0.01	1.05 (1.01, 1.10 $^{\$}$)	9.01	0.029 *	0.02 ^{S}	1.12 (1.10, 1.37 $^{\$}$)
Male	13.95	0.003 *	0.02 ^{S}	1.10 (1.04, 1.17 $^{\$}$)	14.19	0.003 *	0.04 ^{S}	1.23 (1.10, 1.37 $^{\$}$)
Female	0.62	0.890	0.00	0.98 (0.91, 1.05)	1.52	0.678	0.00	1.01 (0.90, 1.14)
Team sport	20.12	0.001 *	0.02 ^{S}	1.15 (1.08, 1.22 $^{\$}$)	9.10	0.028 *	0.03 ^{S}	1.25 (1.08, 1.45 $^{\$}$)
Individual sport	0.72	0.868	0.01	0.98 (0.92, 1.04)	3.37	0.338	0.00	1.08 (0.98, 1.18)

Note: a separate analysis was performed for each sample within each phase. *= significant difference in χ^2, $^{\$}$= specific significant difference between Q1 vs Q4. *V*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large.

RAE by Sport Discipline

Sport-specific analyses of the qualifying phase found RAE in men's football only, with an overrepresentation of athletes born in Q1 compared with Q4 (medium effect size). Athletes born in Q1 had 1.38 times higher likelihood of being selected (Table 3). Among male athletes who qualified for the final phase of JDN-2024, taekwondo showed a pronounced RAE (effect size medium), with an overrepresentation of Q1 athletes compared with Q4 and a 1.77 times higher probability of selection. In football, Q1 players were 1.74 times more likely to be selected than Q4 players in qualifying phase (Table 3), and in the final phase a difference was identified between Q1 and Q2. In basketball, the OR for the specific Q1 vs. Q4 comparison was not statistically significant, suggesting that the significant quartile imbalance may reflect differences between other quartile combinations. In female sports, only chess showed evidence of RAE, though in a reversed pattern: athletes born in Q4 were overrepresented relative to those born in Q1 (Table 4). No statistically significant RAE was found across any sports among female athletes (Table 4).

Table 3

Statistical analysis summary of the distributions of male athletes in the qualification phase and final phase of JDN-2024 by sport.

	Qualification phase				*Final phase*			
Sport	χ^2	*p*	*V*	**OR (95% CI) Q1 vs Q4**	χ^2	*p*	*V*	**OR (95% CI) Q1 vs Q4**
Athletics	3.41	0.332	0.01	1.01 (0.84, 1.23)	2.14	0.543	0.00	1.21 (0.84, 1.73)
Boxing	3.05	0.383	0.01	0.96 (0.79, 1.17)	4.78	0.188	0.05	1.17 (0.74, 1.86)
Chess	0.90	0.823	0.00	1.12 (0.89, 1.41)	2.36	0.500	0.00	1.29 (0.66, 2.52)
Cycling	2.57	0.462	0.00	0.88 (0.67, 1.16)	2.19	0.533	0.00	0.96 (0.63, 1.46)
Artistic gymnastics	2.57	0.463	0.00	1.00 (0.38, 2.66)	5.77	0.123	0.17	1.25 (0.29, 5.34)
Rhythmic gymnastics	-	-	-	-	-	-	-	-
Weightlifting	5.57	0.134	0.08	1.00 (0.61, 1.65)	3.30	0.347	0.03	1.20 (0.58, 2.50)
Judo	0.68	0.876	0.00	0.86 (0.59, 1.26)	0.25	0.970	0.00	0.93 (0.56, 1.55)
Karate	0.84	0.839	0.00	0.96 (0.72, 1.28)	4.34	0.226	0.07	1.25 (0.66, 2.38)
Swimming	5.55	0.135	0.05	0.85 (0.62, 1.17)	1.34	0.719	0.00	0.86 (0.49, 1.50)
Skating	1.94	0.584	0.00	0.85 (0.38, 1.89)	1.85	0.605	0.00	0.90 (0.33, 2.47)
Taekwondo	3.81	0.283	0.02	1.10 (0.89, 1.36)	21.78	0.001*	0.16 ^{M}	1.77 (1.09, 2.88 $^{\$}$)
Tennis	3.21	0.359	0.01	0.74 (0.51, 1.07)	4.95	0.175	0.31	0.39 (0.14, 1.07)
Table tennis	7.39	0.060	0.07	1.07 (0.75, 1.52)	5.06	0.168	0.19	1.11 (0.67, 1.85)
Triathlon	1.01	0.801	0.00	1.27 (0.76, 2.12)	5.70	0.127	0.32	2.22 (0.95, 5.20)
Basketball	2.59	0.459	0.00	1.04 (0.81, 1.33)	9.21	0.021*	0.15 ^{M}	1.62 (0.84, 3.13)
Handball	3.68	0.297	0.03	1.18 (0.79, 1.77)	2.06	0.559	0.00	1.23 (0.74, 2.06)
Baseball	3.82	0.281	0.03	1.32 (0.93, 1.87)	4.38	0.222	0.05	1.36 (0.81, 2.27)
Football	33.56	0.001*	0.06 ^{S}	1.38 (1.23, 1.55 $^{\$}$)	7.13	0.068	0.08	1.74 (1.07, 2.83 $^{\$}$)
Futsal	3.76	0.289	0.01	1.15 (0.95, 1.39)	3.13	0.372	0.01	1.52 (0.84, 2.75)
Volleyball	3.68	0.297	0.01	1.02 (0.84, 1.23)	1.66	0.644	0.13	1.10 (0.60, 2.02)
Beach volleyball	3.68	0.297	0.07	1.77 (0.90, 3.49)	3.25	0.355	0.31	1.67 (0.49, 5.70)

Note: a separate analysis was performed for each sport within each phase. *= significant difference in χ^2, $^{\$}$= specific significant difference between Q1 vs Q4. *V*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large.

Table 4
Statistical analysis summary of the distributions of female athletes in the qualification phase and final phase of JDN-2024 by sport.

	Qualification phase				Final phase			
Sport	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**
Athletics	1.63	0.651	0.00	0.93 (0.75, 1.16)	1.03	0.794	0.00	1.02 (0.70, 1.48)
Boxing	5.90	0.116	0.06	0.95 (0.63, 1.44)	4.17	0.243	0.05	0.73 (0.40, 1.35)
Chess	9.30	0.026 *	0.10 ^{M}	0.53 (0.31, 0.89)	5.96	0.113	0.10	0.61 (0.30, 1.24)
Cycling	0.22	0.974	0.00	1.00 (0.53, 1.90)	0.95	0.814	0.00	1.05 (0.49, 2.27)
Artistic gymnastics	1.53	0.675	0.00	0.93 (0.67, 1.29)	2.55	0.465	0.00	0.88 (0.43, 1.79)
Rhythmic gymnastics	3.90	0.272	0.04	0.98 (0.63, 1.52)	4.71	0.194	0.06	1.07 (0.60, 1.92)
Weightlifting	3.80	0.283	0.05	0.97 (0.56, 1.69)	3.41	0.331	0.04	0.90 (0.44, 1.86)
Judo	3.38	0.335	0.02	1.16 (0.70, 1.92)	2.55	0.466	0.00	1.04 (0.56, 1.93)
Karate	1.09	0.777	0.00	0.90 (0.62, 1.31)	0.57	0.903	0.00	1.10 (0.56, 2.17)
Swimming	2.04	0.564	0.00	1.13 (0.82, 1.56)	2.16	0.540	0.00	1.29 (0.72, 2.32)
Skating	1.50	0.681	0.00	0.72 (0.36, 1.45)	0.72	0.867	0.00	1.18 (0.47, 2.96)
Taekwondo	2.36	0.501	0.00	1.10 (0.84, 1.45)	1.36	0.714	0.00	0.98 (0.60, 1.60)
Tennis	3.35	0.341	0.02	1.48 (0.86, 2.55)	4.46	0.215	0.10	2.00 (0.71, 5.62)
Table tennis	2.92	0.403	0.00	0.97 (0.57, 1.65)	1.78	0.617	0.00	0.82 (0.47, 1.45)
Triathlon	1.57	0.664	0.00	1.10 (0.59, 2.05)	4.50	0.212	0.10	1.56 (0.57, 4.28)
Basketball	3.35	0.340	0.02	1.14 (0.77, 1.70)	1.96	0.579	0.00	1.23 (0.64, 2.37)
Handball	1.05	0.788	0.00	1.05 (0.62, 1.78)	1.01	0.797	0.00	1.21 (0.67, 2.20)
Baseball	-	-	-	-	-	-	-	-
Football	2.13	0.545	0.00	0.98 (0.80, 1.21)	3.44	0.328	0.02	0.84 (0.47, 1.49)
Futsal	3.25	0.355	0.01	1.05 (0.77, 1.44)	3.26	0.352	0.02	1.22 (0.67, 2.23)
Volleyball	2.23	0.526	0.00	0.92 (0.70, 1.22)	1.50	0.682	0.00	1.42 (0.73, 2.76)
Beach volleyball	2.57	0.463	0.00	0.82 (0.39, 1.73)	3.86	0.276	0.09	0.42 (0.12, 1.46)

Note: a separate analysis was performed for each sport within each phase. *= significant difference in χ^2, $^{\$}$= specific significant difference between Q1 vs Q4. *V*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large.

RAE by Age Category

Age category and sex analyses revealed RAE in male athletes, although with small effect sizes. The effect was mainly observed at ages 16, 19, and 21, with an overrepresentation of athletes born in Q1 compared with Q4 and a 1.20-1.24 times higher probability of selection (Table 5). No RAE was observed among female athletes across any age category. Likewise, when age category and sport type were considered, RAE was identified in team sports with small-to-medium effect sizes. This effect was evident at ages 15 and 19; athletes born in Q1 were overrepresented compared with those born in Q4, with odds ratios of 1.67 and 1.43, respectively. No evidence of RAE was observed in individual sports at any age category (Table 6).

SIPD Sociedad Iberoamericana de Psicología del Deporte

Table 5

Statistical analysis summary of the distributions of athletes according to age category and sex.

	Female				Male			
Age category	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**
≤ 12	3.43	0.330	0.01	0.92 (0.74, 1.13)	4.01	0.260	0.02	1.12 (0.89, 1.40)
13	4.04	0.257	0.02	1.09 (0.85, 1.39)	0.85	0.837	0.00	0.94 (0.73, 1.21)
14	2.00	0.572	0.00	0.86 (0.68, 1.07)	1.51	0.678	0.00	1.15 (0.92, 1.44)
15	3.48	0.322	0.01	1.22 (0.99, 1.50)	5.38	0.146	0.03	1.24 (1.03, 1.49 ^{S})
16	7.31	0.063	0.04	0.89 (0.72, 1.10)	9.63	0.022 *	0.04 ^{S}	1.24 (1.06, 1.45 ^{S})
17	1.13	0.768	0.00	1.00 (0.83, 1.21)	3.92	0.269	0.01	1.05 (0.92, 1.20)
18	1.44	0.694	0.00	0.92 (0.75, 1.13)	3.07	0.381	0.00	1.00 (0.88, 1.14)
19	5.02	0.170	0.03	0.98 (0.76, 1.27)	12.05	0.007 *	0.05 ^{M}	1.22 (1.02, 1.46 ^{S})
20	1.57	0.667	0.00	0.94 (0.70, 1.25)	1.85	0.602	0.00	0.94 (0.77, 1.15)
≥ 21	0.23	0.972	0.00	1.02 (0.78, 1.34)	15.55	0.001 *	0.07 ^{M}	1.20 (1.00, 1.44 ^{S})

Note: a separate analysis was performed for each age category within each sex. *= significant difference in χ^2, ^{S}= specific significant difference between Q1 vs Q4. *V*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large.

Table 6

Statistical analysis summary of the distributions of athletes according to age category and sport type.

	Individuals				Teams			
Age category	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**	χ^2	***p***	***V***	**OR (95% CI) Q1 vs Q4**
≤ 12	4.69	0.196	0.02	0.99 (0.84, 1.16)	2.33	0.506	0.00	1.63 (0.67, 3.92)
13	0.14	0.987	0.00	1.00 (0.83, 1.21)	2.78	0.426	0.00	1.12 (0.66, 1.89)
14	0.08	0.994	0.00	0.99 (0.83, 1.19)	0.21	0.976	0.00	0.99 (0.70, 1.38)
15	0.67	0.881	0.00	1.06 (0.90, 1.26)	17.71	<0.001 *	0.09 ^{M}	1.67 (1.30, 2.14 ^{S})
16	2.16	0.540	0.00	1.04 (0.87, 1.24)	9.85	0.020 *	0.04 ^{S}	1.17 (0.99, 1.40)
17	0.11	0.991	0.00	1.01 (0.85, 1.21)	1.33	0.722	0.00	1.04 (0.91, 1.20)
18	3.72	0.294	0.01	0.91 (0.76, 1.10)	5.83	0.120	0.02	1.01 (0.89, 1.16)
19	5.95	0.114	0.04	0.82 (0.65, 1.03)	22.02	<0.001 *	0.08 ^{M}	1.43 (1.18, 1.74 ^{S})
20	4.88	0.181	0.03	0.76 (0.59, 0.98)	3.69	0.296	0.01	1.09 (0.88, 1.35)
≥ 21	3.52	0.318	0.01	1.11 (0.87, 1.41)	8.66	0.034 *	0.05 ^{S}	1.17 (0.96, 1.42)

Note: a separate analysis was performed for each age category within each sport type. *= significant difference in χ^2, ^{S}= specific significant difference between Q1 vs Q4. *V*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large.

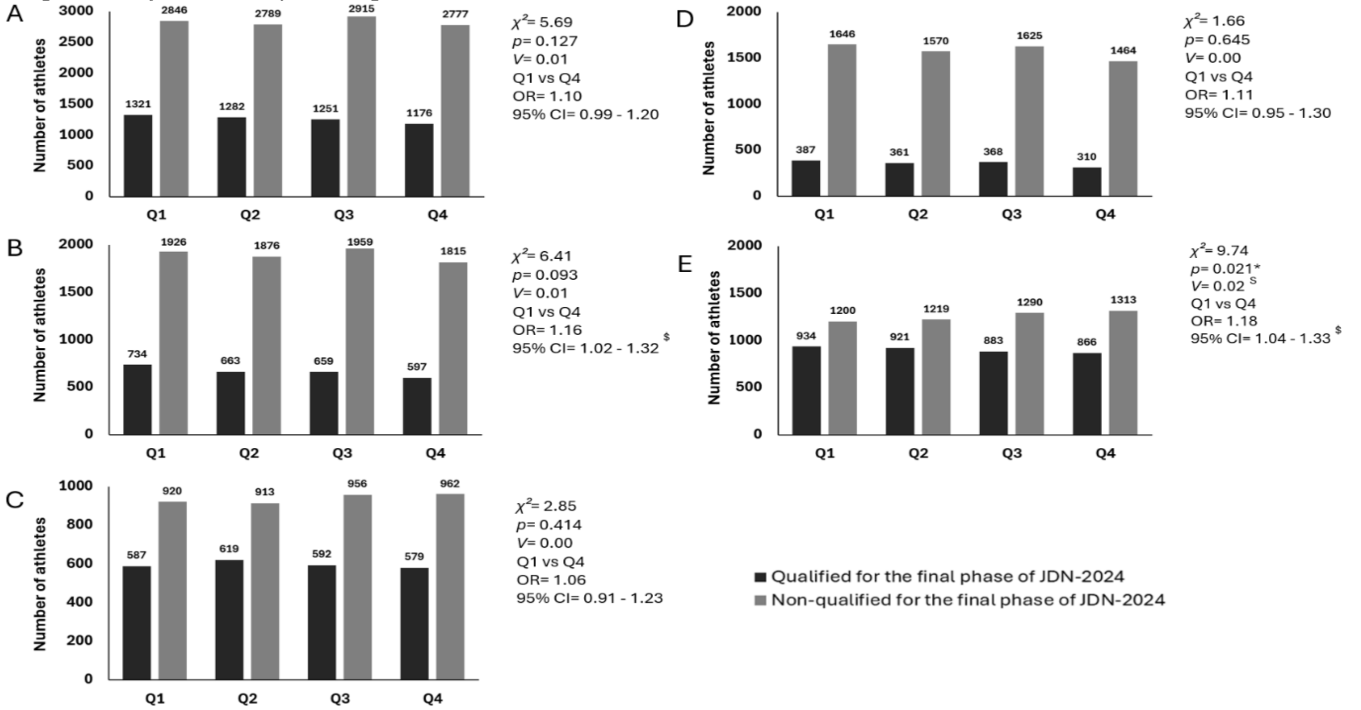
RAE and Competitive Performance

The chi-square tests of independence only showed a statistically significant relationship between birth quartiles and qualification for the JDN-2024 in individual sports (Figure 1. E). No statistically significant relationships were observed in the other analyses.

Regarding the relationship between birth quartiles and winning a medal, Figure 2. A to 2. E did not show any significant associations. Likewise, the OR and 95% CI values do not indicate a significantly higher likelihood for athletes born in Q1 to qualify for the JDN-2024 or to win a medal compared to those born in Q4.

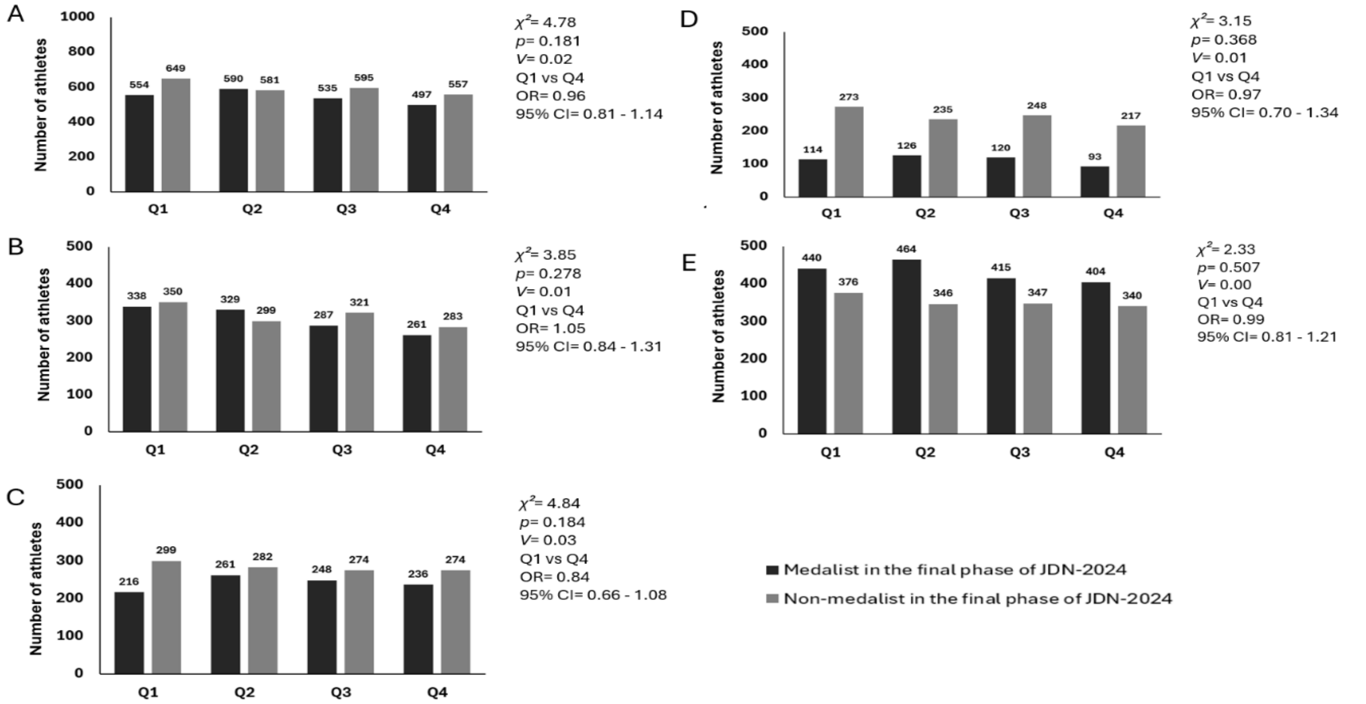
Figure 1

Proportion of athletes by birth quartile.



Note: a separate analysis was performed for each cross-tabulation (4 x 2). *= significant difference in χ2, $= specific significant difference between Q1 vs Q4. Vc= corrected Cramer's V: S= small, M= medium, L= large. Shows the proportion of athletes by birth quartile and qualification for the JDN-2024 for: the total sample of 16357 athletes (A); separately for male athletes (B), female athletes (C); for team sports (D); and for individual sports (E).

Figure 2
Shows the proportion of athletes by birth quartile and medalist.



Note: a separate analysis was performed for each cross-tabulation (4 x 2). *= significant difference in χ^2, $= specific significant difference between Q1 vs Q4. *Vc*= corrected Cramer's V: ^{S}= small, ^{M}= medium, ^{L}= large. Since medal attainment data were unavailable for rhythmic gymnastics, tennis, and table tennis, the medal analysis was conducted on 4558 athletes (of the 5030 who advanced to the final phase) for whom complete data were available. Shows the proportion of athletes by birth quartile and medalist in the JDN-2024 for: the total sample of 4558 athletes (A); separately for male athletes (B), female athletes (C); for team sports (D); and for individual sports (E).

DISCUSSION

This study explored the RAE among athletes participating in the JDN-2024 from Costa Rica according to sex, sport type, age category, and sport performance. The main results confirm the presence of RAE among athletes who qualified for the final phase, particularly among male athletes and in team sports, with an overrepresentation of athletes born in Q1. These findings agree with previous studies from different countries that have reported RAE in youth program sports (Lidor et al., 2021; Romann et al., 2018), and with evidence showing that RAE magnitude varies across disciplines, sex, and age category (Cobley et al., 2009; Gil et al., 2021; Smith et al., 2018).

The overrepresentation of relatively older athletes in youth tournaments is commonly attributed to a combination of biological, contextual, and organizational factors. From a biological perspective, early maturation in older athletes tends to be associated with more favorable anthropometric and physical profiles (Rubajczyk & Rokita, 2020) and superior cognitive and emotional characteristics compared to their younger peers (Musch & Grondin, 2001). These differences may contribute to a systemic bias in which coaches tend to favor athletes born in the first month of the cutoff year, reinforcing perceptions of greater ability and better performance in competition among those who are relatively older (Lidor et al., 2021; Rubajczyk & Rokita, 2020).

On the other hand, cultural factors, sport governance, program structure, and family influence also influence RAE within youth sport systems (Wattie et al., 2015). The use of fixed annual age-grouping limits can create systematic age gaps of up to 12 months within the same competitive category, disproportionately disadvantaging those born later in the selection year (Cobley et al., 2009). Sports with higher participation and more rigorous selection criteria tend to increase the RAE due to competition for limited places, which increases selective pressure and could favor relatively older or chronologically older athletes (Kelly et al., 2022; Porto et al., 2021; Voet et al., 2022). Likewise, this can exert selection pressures through early sport specialization and prioritizing winning over formation, increasing the likelihood that coaches and administrators will favor athletes who demonstrate immediate physical superiority in competition (Sweeney et al., 2024; Wattie et al., 2015). Furthermore, family influence, through early registration and greater investment in training for children considered talented, can further widen the developmental gaps between older and younger athletes (Porto et al., 2021; Wattie et al., 2015).

Regarding female athletes, RAE was absent across sports, except in chess during the qualifying phase, where a reversed pattern was observed: athletes born in Q4 were overrepresented relative to those in Q1. This reversed RAE may be explained by the cognitively demanding nature of chess, in which accumulated training or early cognitive specialization can confer more advantage than physical attributes (Gil et al., 2021; Helsen et al., 2016). Nevertheless, this finding should be interpreted with caution, given the small female chess subsample (n= 187) and the absence of a significant effect in the final phase. The widespread absence of RAE among female athletes aligns with systematic reviews reporting mild to moderate effects in female sports contexts (Smith et al., 2018), which could be explained by a lower density of athletes and selection criteria less biased toward early physical maturity (Faber et al., 2020; Romann et al., 2018).

In team sports, players born in Q1 were 1.15 and 1.25 times more likely to be selected than those born in Q4 in the qualifying and final phases, respectively. Sport-specific analyses identified RAE in basketball and football among male athletes, a result well-documented in these disciplines (Gil et al., 2021; Ibáñez et al., 2018; Roberts et al., 2021; Tascioglu et al., 2023). In football, the pattern held across both phases. The chi-square test in the final phase fell just short of significance (p= 0.068), but the Q1 vs Q4 odds ratio rose from 1.38 in the qualifying phase to a significant 1.74 (95% CI: 1.07-2.83) in the final phase. Rather than easing off, the advantage for athletes born early in the year was stronger among those who reached the final stage. This fits the idea that successive selection filters accumulate relative-age bias rather than dilute it (Lupo et al., 2019; Roberts et al., 2021). In basketball, although the difference was observed between Q2 vs Q4 rather than Q1 vs Q4, this pattern still reflects a systematic selection advantage for relatively older athletes in basketball (Ibáñez et al., 2018; Tascioglu et al., 2023). Among individual sports, taekwondo was the only discipline showing RAE in male athletes during the final phase with effect size medium, consistent with international evidence reporting an overrepresentation of athletes born in Q1 in taekwondo (Cular et al., 2024; Minsoo et al., 2022). This could be because physical characteristics can offer competitive advantages during the youth stages, and coaches opt for relatively older athletes with greater physical development and psychosocial maturity for the tournament (Cular et al., 2024; de Almeida-Neto et al., 2023).

Age-specific analyses revealed that RAE was not uniformly distributed across age categories. Among male athletes, significant effects were observed at ages 16, 19, and ≥21, with Q1 showing 1.20 to 1.24 times greater likelihood of selection than Q4 (Table 5). When sport type was considered alongside age, RAE in team sports was most pronounced at ages 15 and 19, with medium effect sizes and OR of 1.67 and 1.43, respectively (Table 6). These findings suggest that RAE is not constant across development but may intensify at critical transition points in the competitive pathway (Hollings et al., 2014; Reed et al., 2017). The accentuated effect at age 15 likely reflects increased selection pressure as athletes begin to specialize and compete for limited spots, a period during which maturation-related physical advantages are notable (Kearney et al., 2018; Kirkeberg et al., 2022). The resurgence of RAE at age 19 in team sports may reflect the transition to senior competition, where relatively older athletes are preferentially retained (Ferragut et al., 2021; Lupo et al., 2019).

When all individual sports were examined together, a statistically significant relationship was observed between birth quartile and qualification for the final phase (effect size small) (Figure 1.E), despite the absence of significant sport-specific effects in most individual disciplines. This apparent discrepancy may reflect the aggregation of small, consistent trends across multiple sports that, while individually below the threshold of significance, collectively produce a detectable pattern, albeit with the peculiarity that the effect size was small. Despite this, the literature demonstrates that RAE magnitude tends to increase as athletes progress through successive selection stages toward national representation (Aku & Yang, 2024; Brazo-Sayavera et al., 2018; Kirkeberg et al., 2022), suggesting that competitive filtering across individual sports may cumulatively favor relatively older athletes.

Despite the selection advantages associated with being born in Q1, RAE did not show a significant relationship with medal attainment at the JDN-2024, either in the overall analysis or in specific comparisons. Although previous studies have linked birth quartile to competitive success, including medal attainment in track and field (Bezuglov et al., 2022) and team performance in championships (Tascioglu et al., 2023), the present findings suggest that early selection advantages do not necessarily translate into superior competitive performance, as has been reported in team sports (de Oliveira Castro et al., 2024; Folle et al., 2026). The absence of an association between birth quartile and medal attainment at the JDN-2024 suggests that, once athletes reach the final stage, the early advantages that shaped selection no longer separate medalists from non-medalists, a decoupling between selection bias and performance already reported elsewhere (de la Rubia et al., 2020; Kelly et al., 2022). However, it is important to recognize that selection processes that favor early maturity can lead to relatively younger, but potentially talented, athletes being systematically overlooked (de la Rubia et al., 2020). Coaches should therefore exercise caution when making selection decisions based on temporary developmental advantages, as such differences tend to diminish over time through growth and training (Hollings et al., 2014; Kirkeberg et al., 2022; Sweeney et al., 2024).

This reinforces the idea that RAE is driven by selection pressure rather than by chronological age on its own. A useful contrast is with school-based sport, where the aim is participation and motor learning more than selection. Evidence from Brazilian school competitions shows that RAE does surface there, but mainly in the youngest category (under-11) and fades in the older ones, once the early maturational gap narrows and the selective stakes ease (Savassi Figueiredo et al., 2023). This pattern fits the present findings: where competitive filtering is weaker, the mechanisms that produce RAE weaken with it. That the effect concentrates in the selective, high-stakes environment of a national tournament, but thins out in more formative or lower-tier settings, points to the selection process itself as the source of the bias reported here (Franchi et al., 2026; Savassi Figueiredo et al., 2023).

LIMITATIONS

A few limitations should be kept in mind when reading these results. The analysis covers a single edition of the JDN, so it reflects one moment rather than a trend across years. Once the sample was split by sex, phase, and quartile, several disciplines were left with small subsamples, which constrains how far the sport-specific findings can be taken; the reversed effect in female chess (n= 187) is the clearest case. Medal data were unavailable for rhythmic gymnastics, tennis, and table tennis, so the performance analysis rests on 4558 of the 5030 finalists. The dataset also lacked anthropometric and maturational measures, which would have helped separate biological maturity from birth-quartile effects. Tracking several editions and adding maturity and body-size data would help clarify the mechanisms behind the patterns reported here.

CONCLUSIONES

The analyses of JDN-2024 from Costa Rica confirm the presence of RAE among qualified athletes, with a more pronounced effect observed in male sports in general and in specific team sports such as basketball and football, as well as in individual sports like taekwondo, where being born in the early months of the year was associated with a higher likelihood of selection. Among female athletes, the effect was largely absent, the exception being chess, which showed a reversed pattern in the qualifying phase with athletes born late in the year overrepresented. Birth quartile bore no clear association with either qualifying for the final stage or winning a medal. Therefore, although RAE was present, it did not determine competitive performance.

PRACTICAL APPLICATIONS

These results point to the value of reviewing how talent is identified, selected, and developed across sport disciplines. Relative age should not work as an exclusion criterion, but as a variable that informs compensatory strategies to reduce bias and support more stable developmental pathways, with selection criteria that favor long-term development over short-term performance advantages. For the Costa Rican system specifically, ICODER and the sport federations could record and monitor birth-quartile distributions within the JDN registration platform, which already holds the data needed to do so. Coaches selecting squads in football and taekwondo, where the effect was clearest, should keep in mind that a late-born athlete who reaches the final stage has already passed through a tougher filter and is not a weaker prospect. Steps that fit a national-games structure could include grouping by maturity rather than birth year in the youngest categories, giving evaluators quartile-corrected reference data so that early physical maturity is not read as talent, and adding anthropometric and maturational measures to better link athlete profiles with RAE and talent-promotion decisions.

ACKNOWLEDGMENTS

The authors thank the administrative and technical staff of the Instituto Costarricense del Deporte y la Recreación (ICODER) for their assistance in making this work possible.

Conflict of interest

The authors reported no potential conflict of interest.

Funding

No funding reported by authors.

Data Availability

The dataset that supports the findings of this study is available from the corresponding author upon reasonable request.

REFERENCES

1. Aku, Y., & Yang, C. (2024). The relative age effect and its influence on athletic performance in Chinese junior female' tennis players. *PLOS ONE, 19*(3), e0298975. https://doi.org/10.1371/journal.pone.0298975

2. Arrieta, H., Torres-Unda, J., Gil, S. M., & Irazusta, J. (2016). Relative age effect and performance in the U16, U18 and U20 European Basketball Championships. *Journal of Sports Sciences, 34*(16), 1530-1534. https://doi.org/10.1080/02640414.2015.1122204

3. Ato, M., López, J., & Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales de Psicología, 29*(3), 1038-1059. https://doi.org/http://dx.doi.org/10.6018/analesps.29.3.178511

4. Bergsma, W. (2013). A bias-correction for Cramér's V and Tschuprow's T. *Journal of the Korean Statistical Society, 42*(3), 323-328. https://doi.org/10.1016/j.jkss.2012.10.002

5. Bezuglov, E., Shoshorina, M., Emanov, A., Semenyuk, N., Shagiakhmetova, L., Cherkashin, A., Pirmakhanov, B., & Morgans, R. (2022). The Relative Age Effect in the Best Track and Field Athletes Aged 10 to 15 Years Old. *Sports, 10*(7), 101. https://doi.org/10.3390/sports10070101

6. Brazo-Sayavera, J., Martínez-Valencia, M. A., Müller, L., Andronikos, G., & Martindale, R. J. J. (2018). Relative age effects in international age group championships: A study of Spanish track and field athletes. *PLOS ONE, 13*(4), e0196386. https://doi.org/10.1371/journal.pone.0196386

7. Brustio, P. R., Modena, R., Boccia, G., Vogliazzo, M., & Kelly, A. L. (2023). Youth-to-senior transition in women's and girls' football: Towards a better understanding of relative age effects and gender-specific considerations. *PLOS ONE, 18*(5), e0283781. https://doi.org/10.1371/journal.pone.0283781

8. Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual Age-Grouping and Athlete Development. *Sports Medicine, 39*(3), 235-256. https://doi.org/10.2165/00007256-200939030-00005

9. Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). New York: Routledge.

10. Cular, D., Babic, M., Katovic, D., Beslija, T., & Kezic, A. (2024). How to Compare Relative Age Effect in Different Sports? A New Methodological Approach—Example of Youth Olympic Games. *Sports, 12*(8), Article 8. https://doi.org/10.3390/sports12080215

11. de Almeida-Neto, P. F., Neto, R. B., Medeiros, I., de Oliveira, F. C. S., de Oliveira Filho, A. G., de Matos, D. G., Dantas, P. M. S., & de Araújo Tinôco Cabral, B. G. (2023). Relative age effect in elite Brazilian athletes in different combat sports: An observational study. *Sport Sciences for Health, 19*, 113-121. https://doi.org/10.1007/s11332-022-01007-x

12. de la Rubia, A., Lorenzo, A., Bjørndal, C. T., Kelly, A. L., García-Aliaga, A., & Lorenzo-Calvo, J. (2021). The Relative Age Effect on Competition Performance of Spanish International Handball Players: A Longitudinal Study. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.673434

13. de la Rubia, A., Lorenzo-Calvo, J., & Lorenzo, A. (2020). Does the Relative Age Effect Influence Short-Term Performance and Sport Career in Team Sports? A Qualitative Systematic Review. *Frontiers in Psychology, 11*. https://doi.org/doi:10.3389/fpsyg.2020.01947

14. de Oliveira Castro, H., Oliveira, V. de, Rocha, M. de S., Souza, W. F. de, Ribeiro, L. D. C., Gomes, S. A., & Figueiredo, L. S. (2024). The Relative Age Effect based on playing-position and performance on Brazilian elite men's basketball. *Cuadernos de Psicología del Deporte, 24*(3), 94-107. https://doi.org/10.6018/cpd.612221

15. Difernand, A., De Larochelambert, Q., Homo, S., Rousseau, F., Antero, J., Toussaint, J.-F., & Sedeaud, A. (2023). Relative age effects in track-and-field: Identification and performance rebalancing. *Frontiers in Physiology, 13.* https://doi.org/10.3389/fphys.2022.1082174

16. Faber, I. R., Liu, M., Cece, V., Jie, R., Martinent, G., Schorer, J., & Elferink-Gemser, M. (2020). The interaction between within-year and between-year effects across ages in elite table tennis in international and national contexts – A further exploration of relative age effects in sports. *High Ability Studies, 31*(1), 115-128. https://doi.org/10.1080/13598139.2019.1596071

17. Ferragut, C., Vila, H., Fernández, J. J., & García, M. Á. S. (2021). Efecto de la edad relativa en la élite del balonmano femenino español y su relación con aspectos antropométricos, de rendimiento y velocidad de lanzamiento. *Cuadernos de Psicología del Deporte, 21*(2), 213-226. https://doi.org/10.6018/cpd.438671

18. Folle, A., Flach, M. C., Souto, L. E., & Beirith, M. K. (2026). Relative Age Effect in Male Basketball Athletes: Association with Individual and Collective Performance. *Revista de Ciencias del Deporte, 22*(1), 55-66. https://doi.org/10.17398/1885-7019.22.55

19. Franchi, S., Martinelli, K., de Souza Balena, L. R., Ribas, J. S. M., & Prat, Q. (2026). Juegos tradicionales con y sin competición: Educar emociones desde la pedagogía de las conductas motrices. En M. Pic & P. Lavega-Burgués (Eds.), *Educar y entrenar conductas motrices: Transferir conocimiento innovador a profesores y entrenadores* (pp. 185-206). Dykinson. https://doi.org/https://doi.org/10.14679/4849

20. Gil, S. M., Bidaurrazaga-Letona, I., Larruskain, J., Esain, I., & Irazusta, J. (2021). The relative age effect in young athletes: A countywide analysis of 9–14-year-old participants in all competitive sports. *PLOS ONE, 16*(7), e0254687. https://doi.org/10.1371/journal.pone.0254687

21. Harriss, D. J., MacSween, A., & Atkinson, G. (2019). Ethical Standards in Sport and Exercise Science Research: 2020 Update. *International Journal of Sports Medicine, 40*(13), 813-817. https://doi.org/10.1055/a-1015-3123

22. Helsen, W. F., Baker, J., Schorer, J., Steingröver, C., Wattie, N., & Starkes, J. L. (2016). Relative age effects in a cognitive task: A case study of youth chess. *High Ability Studies, 27*(2), 211-221. https://doi.org/10.1080/13598139.2016.1242063

23. Hollings, S. C., Hume, P. A., & Hopkins, W. G. (2014). Relative-age effect on competition outcomes at the World Youth and World Junior Athletics Championships. *European Journal of Sport Science, 14*(S1), S456-S461. https://doi.org/10.1080/17461391.2012.713007

24. Ibáñez, S. J., Mazo, A., Nascimento, J., & García-Rubio, J. (2018). The Relative Age Effect in under-18 basketball: Effects on performance according to playing position. *PLOS ONE, 13*(7), e0200408. https://doi.org/10.1371/journal.pone.0200408

25. Jakobsson, J., Julin, A. L., Persson, G., & Malm, C. (2021). Darwinian Selection Discriminates Young Athletes: The Relative Age Effect in Relation to Sporting Performance. *Sports Medicine - Open, 7*(1), 16. https://doi.org/10.1186/s40798-021-00300-2

26. Kearney, P. E., Hayes, P. R., & Nevill, A. (2018). Faster, higher, stronger, older: Relative age effects are most influential during the youngest age grade of track and field athletics in the United Kingdom. *Journal of Sports Sciences, 36*(20), 2282-2288. https://doi.org/10.1080/02640414.2018.1449093

27. Kelly, A. L., Brown, T., Reed, R., Côté, J., & Turnnidge, J. (2022). Relative Age Effects in Male Cricket: A Personal Assets Approach to Explain Immediate, Short-Term, and Long-Term Developmental Outcomes. *Sports, 10*(3), 39. https://doi.org/10.3390/sports10030039

28. Kirkeberg, A., Roaas, T. V., Gundersen, H., & Dalen, T. (2022). Relative Age Effect Among the Best Norwegian Track and Field Athletes of All Time: Comparisons of Explosive and Endurance Events. *Frontiers in Psychology, 13.* https://doi.org/10.3389/fpsyg.2022.858095

29. Lidor, R., Maayan, Z., & Arnon, M. (2021). Relative Age Effect in 14- to 18-Year-Old Athletes and Their Initial Approach to This Effect—Has Anything Changed Over the Past 10 Years? *Frontiers in Sports and Active Living, 3*. https://doi.org/10.3389/fspor.2021.622120

30. Lorenzo-Calvo, J., de la Rubia, A., Mon-López, D., Hontoria-Galán, M., Marquina, M., & Veiga, S. (2021). Prevalence and Impact of the Relative Age Effect on Competition Performance in Swimming: A Systematic Review. *International Journal of Environmental Research and Public Health, 18*(20), 10561. https://doi.org/10.3390/ijerph182010561

31. Lupo, C., Boccia, G., Ungureanu, A. N., Frati, R., Marocco, R., & Brustio, P. R. (2019). The Beginning of Senior Career in Team Sport Is Affected by Relative Age Effect. *Frontiers in Psychology, 10.* https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01465

32. Minsoo, J., Jiwun, Y., & Hyo-Jun, Y. (2022). The Relative Age Effect of Elite Taekwondo Athletes. *Annals of Applied Sport Science, 10*(2), 0-0. https://doi.org/10.52547/aassjournal.998

33. Musch, J., & Grondin, S. (2001). Unequal Competition as an Impediment to Personal Development: A Review of the Relative Age Effect in Sport. *Developmental Review, 21*(2), 147-167. https://doi.org/10.1006/drev.2000.0516

34. Porto, L., Flach, M., do Nascimento, R., Dallegrave, E., do Nascimento, J., & Folle, A. (2021). Relative age effect on basketball: Implications for the selection of successful players. *Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación*, *42*, 266-275. https://doi.org/10.47197/retos.v42i0.83847

35. Reed, K. E., Parry, D. A., & Sandercock, G. R. H. (2017). Maturational and social factors contributing to relative age effects in school sports: Data from the London Youth Games. *Scandinavian Journal of Medicine & Science in Sports, 27*(12), 2070-2079. https://doi.org/10.1111/sms.12815

36. Roberts, S. J., McRobert, A. P., Rudd, J., Enright, K., & Reeves, M. J. (2021). Research in Another un-Examined (RAE) context. A chronology of 35 years of relative age effect research in soccer: Is it time to move on? *Science and Medicine in Football, 5*(4), 301-309. https://doi.org/10.1080/24733938.2020.1841278

37. Romann, M., Rössler, R., Javet, M., & Faude, O. (2018). Relative age effects in Swiss talent development – a nationwide analysis of all sports. *Journal of Sports Sciences, 36*(17), 2025-2031. https://doi.org/10.1080/02640414.2018.1432964

38. Rubajczyk, K., & Rokita, A. (2020). The Relative Age Effect and Talent Identification Factors in Youth Volleyball in Poland. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.01445

39. Saavedra-García, M., Gutiérrez-Aguilar, O., Sa-Marques, P., & Fernández-Romero, J. J. (2016). Efecto de la edad relativa en el atletismo español. *Cuadernos de Psicología del Deporte, 16*(1), 275-286.

40. Savassi Figueiredo, L., Ribeiro, L. d. C., Barbosa, T. F., da Silva, D. G., & Fonseca, F. S. (2023). Are relative age effects pervasive in lower competitive tiers of school sports? An investigation of student-athletes from Minas Gerais. *Cuadernos de Psicología del Deporte, 23*(2), 260-272. https://doi.org/10.6018/cpd.512511

41. Silva, L. A., Leonardo, L., Andrade Rodrigues, H. de, & Krahenbühl, T. (2022). The Relative Age Effect in invasion team sports: A systematic review in youth sports. *Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación, 46*, 641-652. https://doi.org/10.47197/retos.v46.94211

42. Smith, K. L., Weir, P. L., Till, K., Romann, M., & Cobley, S. (2018). Relative Age Effects Across and Within Female Sport Contexts: A Systematic Review and Meta-Analysis. *Sports Medicine, 48*(6), 1451-1478. https://doi.org/10.1007/s40279-018-0890-8

43. Sweeney, L., de la Rubia, A., Taylor, J., & Bjørndal, C. T. (2024). Looking beyond relative age to understand relative advantage and disadvantage in talent development. *Frontiers in Sports and Active Living, 6.* https://doi.org/10.3389/fspor.2024.1470944

44. Tascioglu, R., Atalag, O., Yuksel, Y., Kocaeksi, S., Güven, G., Akyildiz, Z., & Nobari, H. (2023). Relative age effect and performance in elite youth male basketball. *Scientific Reports, 13*(1), 4544. https://doi.org/10.1038/s41598-023-31785-4

45. Voet, J. G., Lamberts, R. P., de Koning, J. J., & van Erp, T. (2022). The role of the relative age effect on talent identification in professional road cycling. *Journal of Sports Sciences, 40*(19), 2159-2165. https://doi.org/10.1080/02640414.2022.2144877

46. Wattie, N., Schorer, J., & Baker, J. (2015). The Relative Age Effect in Sport: A Developmental Systems Model. *Sports Medicine, 45*(1), 83-94. https://doi.org/10.1007/s40279-014-0248-9

47. World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *Journal of the American Medical Association, 310*(20), 2191-2194. https://doi.org/10.1001/jama.2013.281053